D.Suguna *et al*, International Journal of Computer Science and Mobile Applications,
Vol.2 Issue. 8, August- 2014, pg. 06-14 **ISSN: 2321-8363**

FAULT NODE RECOVERY ALGORITHM TO ENHANCE THE LIFETIME OF A WIRELESS SENSOR NETWORK

D.Suguna
Research Scholar, School of Computer Science and Engineering, Bharathidasan University
Tiruchirappalli-620023, India
dsuguna.2012@gmail.com

Dr. K.Elangovan
Assistant Professor, School of Computer Science and Engineering, Bharathidasan University
Tiruchirappalli-620023, India
murthy.elango@gmail.com

Abstract

This paper proposes a fault node recovery algorithm to enhance the lifetime of a wireless sensor network when some of the sensor nodes shut down. This algorithm is based on the grade diffusion algorithm combined with the genetic algorithm. The algorithm can result in fewer replacements of sensor nodes and more reused routing paths. In this proposed algorithm increases the number of active nodes up to 8.7 times, reduces the rate of data loss by approximately 98.8%, and reduces the rate of energy consumption by approximately 31.1%. Sensors in a wireless sensor networks are having tendency to fail, due to the energy depletion, hardware failures, environmental conditions etc. Fault tolerance is one of the critical issues in Wireless sensor network. The existing fault tolerance mechanisms either consume significant extra energy to detect and recover from the failures or need to use additional hardware and software resources. The proposed algorithm enhances the lifetime of a sensor nodes shut down and it depends on ladder diffusion Algorithm combined with the genetic algorithm. It can result in fewer replacements of sensor nodes with more reused routing paths and also increases the number of active nodes, reduce the rate of data loss with reduced energy consumption.

Keywords: sensor networks (WSN), Genetic algorithm, Grade diffusion (GD) algorithm, Directed Diffusion Algorithm

1. Introduction

Recent advances in micro processing, wireless and battery technology, and smart sensors have enhanced data processing wireless communication, and detection capability. In sensor networks, each sensor node has limited wireless computational power to process and transfer the live data to the base station or data collection center. Therefore, to increase the sensor area and the transmission area the wireless sensor network usually contains many sensor nodes. Generally, each sensor node has a low level of battery power that cannot be replenished. When the energy of a sensor node is exhausted, wireless Sensor network leaks will appear, and the failed nodes will not relay data to the other nodes during transmission processing. Thus, the other sensor nodes will be burdened with increased transmission processing. The main features of WSNs, as could be deduced by the general description given in the previous sections, are: scalability with respect to the number of nodes in the network, self-organization, self-healing, energy efficiency, a sufficient degree of connectivity among nodes, low-complexity, low cost and size of nodes. Those protocol architectures and technical solutions providing such features can be considered as a potential framework for the creation of these networks, but, unfortunately, the definition of such a protocol architecture and technical solution is not simple, and the research still needs to work on it.

The massive research on WSNs started after the year 2000. However, it took advantage of the outcome of the research on wireless networks performed since the second half of the previous century. In particular, the study of ad hoc networks attracted a lot of attention for several decades, and some researchers tried to report their skills acquired in the field of ad hoc networks, to the study of WSNs.

This paper proposes a fault node Recovery algorithm to enhance the lifetime of a wireless sensor network. When some of the sensor nodes shut down, either because they no longer have battery energy or they have reached their operational threshold. Using the Fault node algorithm can result in fewer replacements of sensor nodes and more reused routing paths. Thus, the algorithm not only enhances the Wireless sensor network lifetime but also reduces the cost of replacing the sensor nodes.

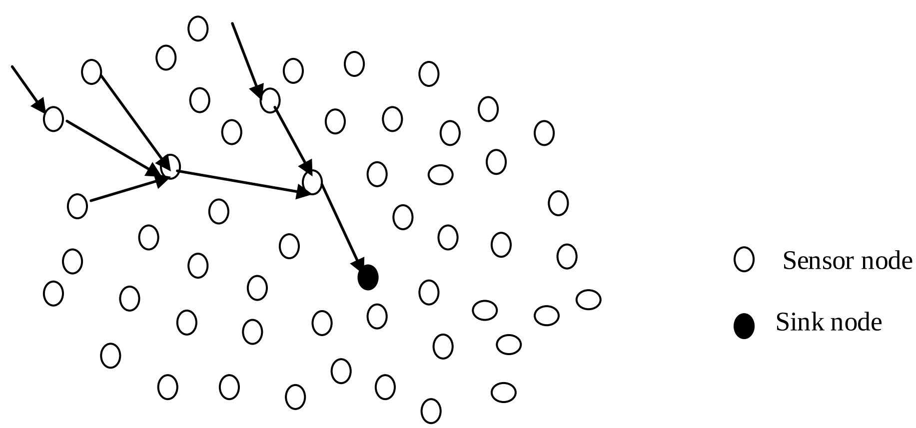

Fig. 1 wireless sensor node routing

2. Related Work

Many techniques have been proposed till now for fault detection and recovery. Sony Jia et al. [1] A recovery Algorithm based on Minimum Distance Redundant Nodes. By employing redundant nodes carefully, the recovery algorithm is deployed on the sink node with unconstrained energy consumption which knows the locations of all active nodes and redundant nodes in the Wireless sensor network. Simulation results demonstrate that, by choosing appropriate number of redundant nodes, this algorithm will have great recovery accuracy and coverage quality, also achieve the purpose of prolonging the lifecycle of Wireless sensor network.

Muhammed Asim et al. [2] extended the cellular approach and proposed a new fault management mechanism to deal with fault detection and recovery of wsn. They proposed a hierarchical structure to properly distribute fault management tasks among sensor nodes by introducing more "self-managing‟ functions. The proposed failure detection and recovery algorithm has been compared with some existing related work and proven to be more energy efficient.

Charu virmani and Khushboo Garg [3] discussed about already implemented algorithms and existing approaches of network fault management and compare their features for an effective one.

Prasenjitchanak et al. [4] proposed an energy efficient node fault diagnosis and recovery for wireless sensor networks referred as fault tolerant multipath routing scheme for energy efficient wireless sensor network (FTMRS).The FTMRS is based on multipath data routing scheme. One shortest path is use for main data routing in FTMRS technique and other two backup paths are used as alternative path for faulty network and to handle the overloaded traffic on main channel. Shortest path data routing ensures energy efficient data routing. The performance analysis of FTMRS shows better results compared to other popular fault tolerant techniques in wireless sensor networks.

Wireless sensor networks (WSNs) enable new applications and require non-conventional paradigms for protocol design due to several constraints. Owing to the requirement for low device complexity together with low energy consumption (i.e., long network lifetime), a proper balance between communication and signal/data processing capabilities must be found. This motivates a huge effort in research activities, standardization process, and industrial investments on this field since the last decade. This survey paper aims at reporting an overview of WSNs technologies, main applications and standards, features in WSNs design, and evolutions. In particular, some peculiar applications, such as those based on environmental monitoring, are discussed and design strategies highlighted; a case study based on a real implementation is also reported. Trends and possible evolutions are traced. Emphasis is given to the IEEE 802.15.4 technology, which enables many applications of WSNs. Some example of performance characteristics of 802.15.4-based networks are shown and discussed as a function of the size of the WSN and the data type to be exchanged among node.

Jian yang et al. [6] proposed a strategy for the WSN in that Query processing In Network Distributed & Dynamic Database Using Two Phase Sampling Techniques Peer-to-peer database are becoming prevalent on the internet for distribution and sharing of documents, application, and other digital media. The Problem of Answering Large-Scale Ad Hoc Analysis Queries. For example, Aggregation queries, on these databases poses unique challenges. Exact solution can be time consuming and difficult to implement, given the distributed and dynamic nature of peer-to-peer database. In this thesis we present novel sampling-based techniques for approximate answering of adhoc aggregation queries in such database.

Two phase sampling algorithm the database efficiently in the p2p environment is complicated due to several factors : the data is distributed across many peers, within each peer, the data is dis often highly correlated, and moreover, even collecting a random sample of the peers is difficult to accomplish. To counter these problem, we have developed an adaptive two-phase sampling approach based on random walks of the p2p graph, as well as block-level sampling techniques.

3. Proposed Work

Transfer proposes an algorithm to search for and replace fewer sensor nodes and to reuse the most routing paths. One scheme, the genetic algorithm. The fault node recovery algorithm based on the grade Diffusion algorithm and replaces sensor nodes that are not functioning. This algorithm not only reuses the most routing paths to increase the WSN lifetime but also reduces the replacement cost.

This thesis proposes an algorithm for wireless sensor node on the grade diffusion algorithm combined with the genetic algorithm. The flow chart is shown in fig 3.1 here the grade diffusion algorithm is employed to route paths for data relay and transmission in wireless sensor networks, reducing both power consumption and processing time to build the routing table and simultaneously avoiding the generation of circle routes. Moreover, to ensure the safety and reliability of data transmission, grade diffusion algorithm provides backup routes to avoid wasted power and processing time when rebuilding the routing table in case part of sensor nodes are missing. In the proposed algorithm, the number of nonfunctioning sensor operation, and the parameter bth is calculated according to (1).

The algorithm creates the grade value, routing table, a set of neighbor nodes, and payload value for each sensor node, using grade diffusion algorithm. The sensor nodes the event data to the sink node according to the gd algorithm when events appear.

Then, Bth is larger than zero, the algorithm will be invoked and replace nonfunctioning sensor nodes by functional nodes selected by the wireless sensor network can continue to work as long as the operators are willing to replace sensors.

(1) Grade is the sensor nodes grade value. The variable Nioriginal is the number of sensor nodes with the grade value i. the variable Ninow is the number of sensor nodes still functioning at the current time with grade value i. The parameter β is set by the user and must have value between and 1. If the of sensor nodes that function for each grade is less than β, Ti will become 1,and Bth will be larger than zero. Then, the algorithm will calculate the sensor nodes.

Algorithm goal is to replace few sensor nodes that are not functioning and have low battery power and repeatedly using the routing path. The above approach will ultimately increase the life time and deduce the cost of node replacement.

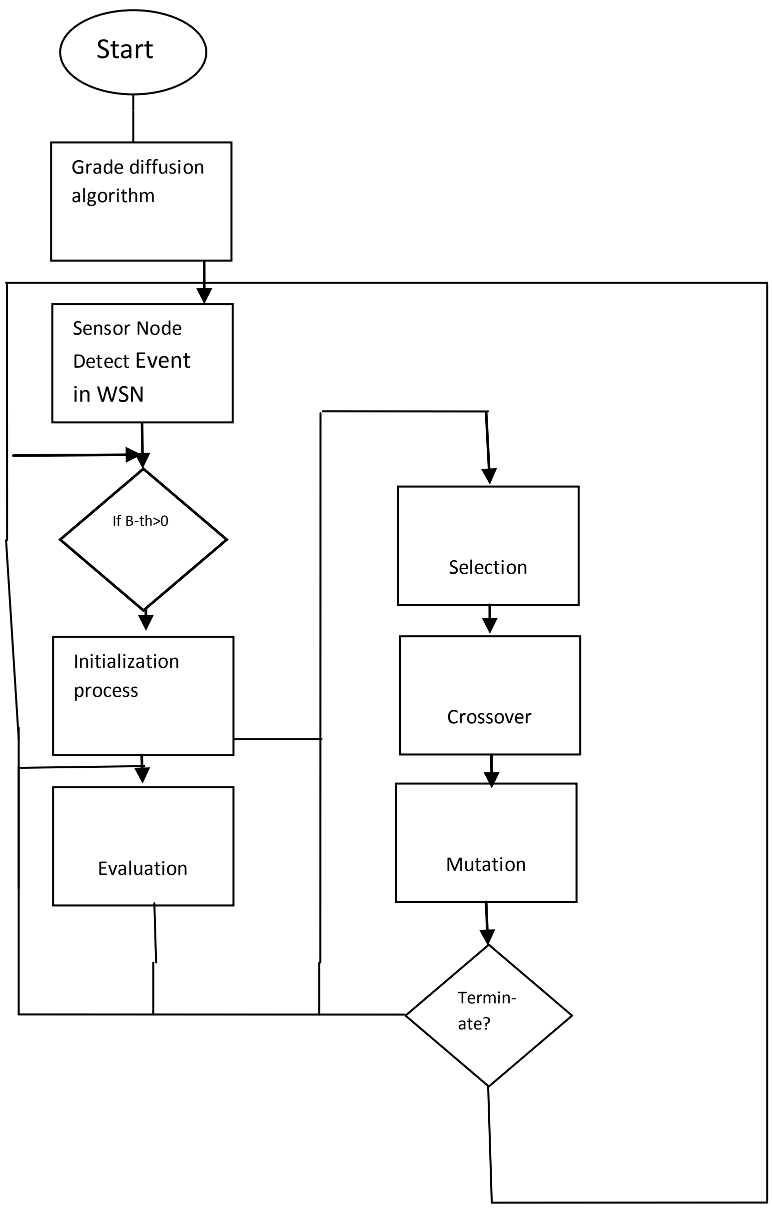

Fig.2.Proposed FNR algorithm diagram

Replacing using the genetic algorithm. The parameters are encoded in binary string and serve as the chromosomes for the genetic algorithm. The elements i.e., the genes, in the binary strings are adjusted to minimize or maximize the fitness value. The fitness function generates its fitness value, which is composed of multiple variable to be optimized by the genetic algorithm. At each iteration of the genetic algorithm, a predetermined number of individuals will produce fitness values ass0ciated with the chromosomes.

Sensor network routing includes the directed diffusion algorithm and grade diffusion algorithm. Grade diffusion Grade diffusion and ACO and is proposed to solve the power consumption and transmission routing problems in wireless sensor networks. The proposed ladder diffusion algorithm is employed to route paths for data relay and transmission in wireless sensor networks, reducing both power consumption and processing time to build the routing table and simultaneously avoiding the generations of circle routes.

Moreover, to ensure the safety and reliability of data transmission, our algorithm provides backup routes to avoid wasted power and processing time when rebuilding the routing table in case part of sensor n odes are missing.

Directed Diffusion Algorithm

The DD algorithm is a query-driven transmission protocol. The collected data is transmitted only if it matches the query from the sink node. In the DD algorithm, the sink node provides the queries in the form of attribute-value pairs to the other sensor nodes by broadcasting the query packets to the whole network. Subsequently, the sensor nodes send the data back to the sink node only when it fits the queries.

Grade Diffusion Algorithm

H. C. Shih *et al*. presented the Grade Diffusion (GD) algorithm in 2012 to improve the ladder diffusion algorithm using ant colony optimization (LD-ACO) for wireless sensor networks. The GD algorithm not only creates the routing for each sensor node but also identifies a set of neighbor nodes to reduce the transmission loading. Each sensor node can select a sensor node from the set of neighbor nodes when its grade table lacks a node able to perform the relay. The GD algorithm can also record some information regarding the data relay.

Then, a sensor node can select a node with a lighter loading or more available energy than the other nodes to perform the extra relay operation. That is, the GD algorithm updates the routing path in real time, and the event data is thus sent to the sink node quickly and correctly. Whether the DD or the GD algorithm is applied; the grade-creating packages or interested query packets must first be broadcast. Then, the sensor nodes transfer the event data to the sink node, according to the algorithm, when suitable events occur.

Grade diffusion algorithm is proposed to solve the sensor node's transmission problem and the sensor node's loading problem in wireless sensor networks by to arrange the sensor node's routing. In addition to them, the sensor node also can save some backup nodes to reduce the energy consumption for the re-looking routing by our proposed algorithm in case the sensor node's routing is broken. In the simulation, the grade diffusion algorithm can save 29.5% energy and increase 80.39% time than the tradition algorithms for sensor node. Moreover, our proposed algorithm has the less data package transmission loss and the hop count than the tradition algorithms in our simulate setting. Hence, in addition to balance the sensor node's loading and reduce the energy consumption, our algorithm can send the data package to destination node quickly and correctly.

4. Result and Discussion

A simulation of the fault node recovery algorithm as described in performed to verify the method. The experiment was designed based on 3-D space, using 100×100 × 100 units, and the scale of the coordinate axis for each dimension was set at 0 to 100. The radio ranges (transmission range) of the nodes were set to 15 units. In each of these simulations, the sensor nodes were distributed uniformly over the space. There are three sensor nodes randomly distributed in 10 × 10 × 10 space, and the Euclidean distance is at least 2 units between any two sensor nodes. Therefore, there are 3000 sensor nodes in the 3-D wireless sensor network simulator, and the center node is the sink node. The data packages were exchanged between random source/destination pairs with 90000 event data packages. The energy of each sensor node was set to 3600 Ws that is the actual available energy.

Each sensor consumed 1.6 Ws when it conducts a completed data transformation (Rx +T x).s In the GA algorithm, the population size was 20; the crossover rate was 50%; and the mutation rate was 2%. The FNR, DD, and GD algorithms were implemented. The active sensor nodes and total data loss after 90 000 events. The active nodes mean that the sensor node has enough energy to transfer data to other nodes, but some sensor nodes can be deleted from the active nodes list if their routing tables do not have a sensor node that can be used as a relay node, or if they are not in the routing table of any other sensor nodes. The FNR algorithm has 2931 sensor nodes available, but the DD and GD algorithms only have 305 and 256 sensor nodes available after 90 000 events, as shown n Fig. 3.1 This new algorithm enhances the number of active nodes by 8.7 and 10.8 es, respectively. The FNR algorithm has the most active sensor nodes compared with the D and GD algorithms because the algorithm can replace the sensor.

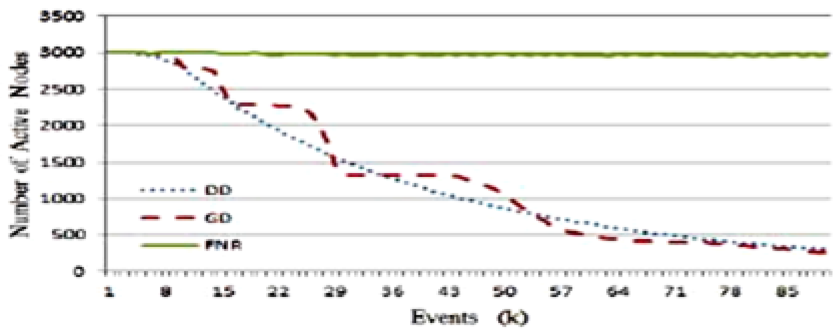

Fig 3.Number of active Nodes

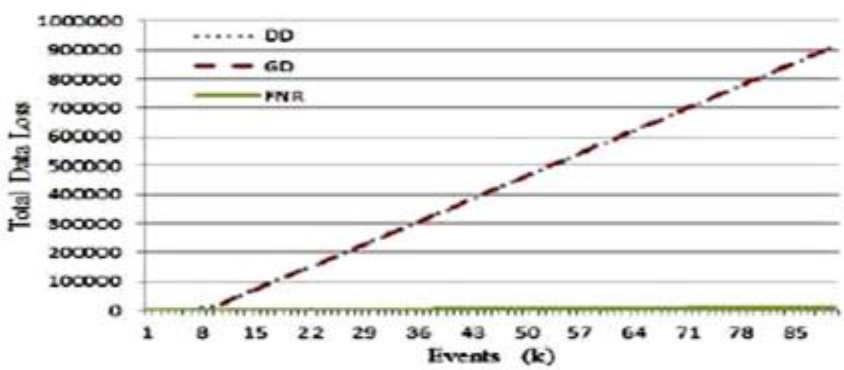

Fig 4.Total data loss

Compares the total data loss using the FNR algorithm to the total data loss using the DD and GD algorithms. In this simulation, event data was destroyed and recorded into loss count if the data had already been relayed over 20 times. Moreover, sensor odes might detect the same event when an event appeared and transfer it to the sink node in this simulation setting. Hence, the total data loss might exceed 90000 vents. Therefore, sensor nodes can detect more events and transfer them to the sink node if the WSN lifetime is increased. In Figs 3.2 the FNR algorithm exhibits smaller data losses because the algorithm can replace fewer sensor nodes and reuse more routing paths if the number of sensor nodes that are nonfunctioning exceeds the threshold.

After the simulation, the FNR algorithm had only suffered 11025 data losses, but the DD and GD algorithm had suffered 912462 and 913449 data losses. This new algorithm can reduce data loss by 98.8% compared to the traditional algorithms. Fig.3.2 compares the average energy consumption of a WSN managed using the FNR algorithm to the average energy consumption using the DD and GD algorithms. The DD and GD algorithms allow the WSN to consume more energy after 8000 events because the inside nodes are energy-depleted, but the outside nodes continue to attempt to transfer event data to the sink node through the inside nodes until they are also energy-depleted. After 90000 events, the DD and GD algorithm-managed WSN had consumed 3495.17 WS and 3298.29 WS respectively.

The proposed algorithm increases the WSN lifetime by replacing some of the sensor nodes that are not functioning. In addition to enhancing the active nodes and reducing the ata losses, the FNR algorithm reduces the relayed energy consumption by reducing the number of data relayed, as the replaced sensor nodes are usually used the most. After 90000 events, using the proposed algorithm, the WSN had consumed only 2407.68 Ws, and, compared to using the DD and GD algorithms, exhibited a reduction in energy consumption of 31.1% and 27%, espectively. After that, we experiment different node densities in our simulation

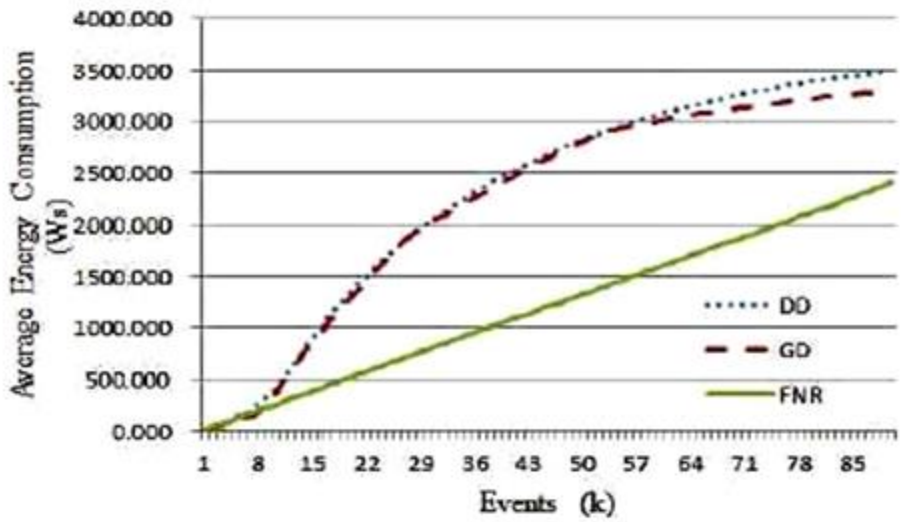

Fig 5. Average energy consumption

ence, the FNR algorithm has the best energy-saving performance no matter under any node densities. The average number of messages that reach the sink node when each algorithm manages the network is compared in Fig.3.4. Using the traditional DD and GD algorithms, the sink node can receive no messages after 8000 events because all of the inside nodes are energy-depleted, and the WSN lifetime is ended. This proposed algorithm replaces energy-depleted sensor nodes to increase the WSN lifetime. Therefore, the average number of messages received using this algorithm is higher than when using the other algorithms.

5. Conclusion

In this paper, proposed algorithm requires a minimal number of communications over the network and provides tunable parameters to maximize performance for various network topologies. We provide a powerful technique for algorithm the various topologies and data clustering. For topologies with very distinct clusters of wireless sensor node, it becomes increasingly difficult to accurately contain random sample due to the inability of random walk process to quickly reach all clusters. The Goal charter tell the wok for the fault node recovery algorithm may be enhanced to exact fault node, which at the present many difficulties because of the use of unstructured wireless sensor network instead of a strutted one and also because of congestion, high latency and difficulty posed while frequently joining or leaving the network without prior data. The Fault node recovery algorithm model used in decrease the cost, which is one of the major considerations compared to accuracy. In future this model expanded using web services and the web server database are be implemented in xml. This model may be elaborate all over the world without any latency with full security.

References

[1] Sony Jia, Wang Bailing, Ping Xiyar, Li Jianfeng and Zhong cheng, "A Recovery Based on Minimum Distance redundant Nodes Fault Management in WSNs," International Journal of control and automation, vol 6,No.2 April 2013.

[2] Muhammed Asim, Hala Mokhtar and Madjid Merabti, "A self-managing fault management mechanism for wireless sensor networks," International Journal of Wirele& Mobile Networks (IJWMN) Vol.2, No.4, November 2010.

[3] Sanam Hasseini, Elmira Moghaddami Khalilzad, "MISR: Multiple Inheritor Selection for Recovery of Nodes in Faulty Cluster in Wireless Sensor Networks," IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 4, No 1, July 2012.

[4] Charu virmani, Khushboo Garg, "Comparative study of fault management algorithms in WSNs," IJERT VOL.1 may 2012.

[5] Prasenjitchanak, Tuhinasamanta, Indrajit Banerjee, "Fault tolerant multipath routing scheme for energy efficient WSNs", „ IJWMN vol 5.No.2 April 2013.

[6] Jian yang, Zhenzhang ye, Zhiyou Ouyang, "A stratergy for fault recovery of wireless sensor networks based on v-svc," Journal of Information and computational science April 2013.

[7] Lilia Paradis and Qi Han, "A survey of fault management in WSNs," Journal of Network and systems management, 2007.

[8] Beenu Baby and Joe Mathew Jacob, "A self-managing fault management in WSNs," ISSN vol 1 July 2013.

[9] Carballido, I. Ponzoni, and N. B. Brignole, "CGD-GA: A graph based genetic algorithm for sensor network design," Inf. Sci., vol. 177, no. 22, pp. 5091–5102, 2007.

[10] F. C. Chang and H. C. Huang, "A refactoring method for cache-efficient swarm intelligence algorithms," Inf. Sci., vol. 192, no. 1, pp. 39–49, Jun. 2012.

[11] S. Corson and J. Macker, "Mobile Ad Hoc Networking (MANET): Routing Protocol Performance Issues and Evaluation Considerations". New York, NY, USA: ACM, 1999.

[12] Z. He, B. S. Lee, and X. S. Wang, "Aggregation in sensor networks with a user-provided quality of service goal," Inf. Sci., vol. 178, no. 9, pp. 2128–2149, 2008.

[13] J. H. Ho, H. C. Shih, B. Y. Liao, and S. C. Chu, "A ladder diffusion algorithm using ant colony optimization for wireless sensor networks," Inf. Sci., vol. 192, pp. 204–212, Jun. 2012.

[14] C. Intanagonwiwat, R. Govindan, D. Estrin, J. Heidemann, and F. Silva, "Directed diffusion for wireless sensor networking," IEEE/ACM Trans.Netw., vol. 11, no. 1, pp. 2–16, Feb. 2003.